2015

Monday, January 31, 2022 12:17 PM

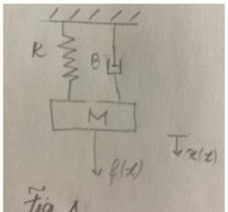


Fig 1.

1. Modelul matematic al sistemului mecanic din Fig1 este dat de ecuatiile:

A. $f(t) = M\frac{dx(t)}{dt} + B\frac{dx(t)}{dt} + Kx(t)$

B. $f(t) = M\frac{d^2x(t)}{dt^2} - B\frac{dx(t)}{dt} + Kx(t)$

C. $f(t) = M\frac{d^2x(t)}{dt^2} + B\frac{d^2x(t)}{dt^2} + Kx(t)$

D. $f(t) = M\frac{d^2x(t)}{dt^2} + B\frac{dx(t)}{dt} + Kx(t)$

Mecanic →	Electric
$f(t)$	e
B	R
K	L
M	C

acceleratia : $\frac{d^2x(t)}{dt^2}$

viteza : $\frac{dx(t)}{dt}$

displacement : $x(t)$

$$\Rightarrow \boxed{f(t) = M\cdot\frac{d^2x(t)}{dt^2} + B\frac{dx(t)}{dt} + K\cdot x(t)}$$

$\Rightarrow$ D

2. Considerand variabilele de stare x1=pozitia si x2=viteza masei M, pt sistemul din Fig1, ecuatiile de stare sunt:

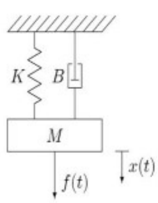
2. Considering the state variables x_1= position and x_2=velocity of mass M, for the system in figure, the state equations are:

A. $\begin{pmatrix}\dot{x}_1\\ \dot{x}_2\end{pmatrix} = \begin{pmatrix}0 & 1\\ -\frac{M}{B} & -\frac{M}{K}\end{pmatrix}\begin{pmatrix}x_1\\ x_2\end{pmatrix} + \begin{pmatrix}0\\ M\end{pmatrix}u$

B. $\begin{pmatrix}\dot{x}_1\\ \dot{x}_2\end{pmatrix} = \begin{pmatrix}0 & 1\\ -\frac{K}{M} & -\frac{B}{M}\end{pmatrix}\begin{pmatrix}x_1\\ x_2\end{pmatrix} + \begin{pmatrix}0\\ \frac{1}{M}\end{pmatrix}u$

C. $\begin{pmatrix}\dot{x}_1\\ \dot{x}_2\end{pmatrix} = \begin{pmatrix}0 & 1\\ \frac{K}{M} & -\frac{B}{M}\end{pmatrix}\begin{pmatrix}x_1\\ x_2\end{pmatrix} + \begin{pmatrix}0\\ \frac{1}{M}\end{pmatrix}u$

D. $\begin{pmatrix}\dot{x}_1\\ \dot{x}_2\end{pmatrix} = \begin{pmatrix}0 & 1\\ \frac{K}{M} & -\frac{B}{M}\end{pmatrix}\begin{pmatrix}x_1\\ x_2\end{pmatrix} + \begin{pmatrix}0\\ 1\end{pmatrix}u$



$$\begin{cases} x_1 = x(t) & \leftarrow \text{pozitia} \\ x_2 = \frac{dx(t)}{dt} & \leftarrow \text{viteza} \end{cases}$$

$$\begin{cases} x_3 = \dot{x}_2 \\ x_2 = \dot{x}_1 \end{cases} \quad \leftarrow \text{accelerația} \qquad \Rightarrow x_3 = \ddot{x}_1$$

$$f(t) = M \cdot \frac{d^2 x_1(t)}{dt^2} + B \cdot \frac{dx_1(t)}{dt} + k x_1(t) \xrightarrow{\text{egalăm } f(t) = u(t)}$$

$$u(t) = M \frac{d^2 x_1(t)}{dt^2} + B \cdot \frac{dx_1(t)}{dt} + k x_1(t)$$

$$\Rightarrow -M \frac{d^2 x_1(t)}{dt^2} = -u(t) + B \frac{dx_1(t)}{dt} + k x_1(t) \quad :\Big| -M$$

$$\dot{x}_2 = \frac{d^2 x_1(t)}{dt^2} = \frac{u(t)}{M} - \frac{B}{M} \frac{dx_1(t)}{dt} - \frac{k x_1(t)}{M}$$

$$\dot{x}_1 = \frac{dx_1(t)}{dt} = x_2$$

$\dot{x}_1 = x_2$

$$\dot{x}_1 = x_2 \Rightarrow \dot{x}_2 = \ddot{x}_1$$

$$\dot{x}_2 = \frac{u(t)}{M} - \frac{B}{M} \cdot x_2 - \frac{K}{M} x_1$$

$$\begin{cases} \Rightarrow \dot{x}_2 = \frac{u(t)}{M} - \frac{B}{M} x_2 - \frac{K}{M} x_1 \leftarrow \\ \Rightarrow \boxed{\dot{x}_1 = x_2} = \underbrace{0 \cdot x_1}_{=0} + \underbrace{x_2}_{\checkmark} + \underbrace{0 \cdot u(t)}_{=0} \end{cases} \qquad \dot{x}_1 = x_2$$

$$\boxed{\begin{pmatrix} \dot{x}_1 \\ \dot{x}_2 \end{pmatrix} = \begin{pmatrix} 0 & 1 \\ -\frac{K}{M} & -\frac{B}{M} \end{pmatrix} \begin{pmatrix} x_1 \\ x_2 \end{pmatrix} + \begin{pmatrix} 0 \\ \frac{1}{M} \end{pmatrix} u(t)}$$

$$0 \cdot x_1 + 1 \cdot x_2 + 0 \cdot u(t) + -\frac{K}{M} \cdot x_1 + -\frac{B}{M} \cdot x_2 + \frac{1}{M} u(t)$$

3. Pentru un compresor care are diametrul conductei de admisie 50mm și cel al conductei de evacuare 20mm se cere viteza v_1 a aerului la admisie și viteza v_2 a aerului în conducta de evacuare știind următoarele: presiunea la intrare 1 atm, presiunea la ieșire 2atm, temp. aerului la intrare 26.85°C, temp. aerului la ieșire 46.85°C, debitul la intrare 3.14 m³/min. Se consideră validă relația pt. densitatea $p = \rho RT$, unde ρ = presiunea și T = temp. în grade Kelvin, R constantă.

la intrare: $P = 1$ atm
$t = 26,85°C$
debit → $Q = 3,14$ m³/min

la ieșire: $P = 2$ atm
$t = 46,85°C$

η – niu

ρ – ro

μ – miu

$$P = \rho R T$$

°K ← greșit

K ← corect

Se dă: la intrare: $P = 1$ atm
$t = 26,85°C \Rightarrow T = 300K$
debit → $Q = 3,14$ m³/min
$diam_1 = 50$ mm

la ieșire: $P = 2$ atm
$t = 46,85°C \Rightarrow T = 320K$
$diam_2 = 20$ mm

Se cere: v_1 ← viteza aer la admisie
v_2 ← viteza aer la evacuare

1) Pentru admisie

$$\boxed{Q = A \boxed{v}}$$ ← viteza

$$\boxed{A = \pi \cdot r^2}$$

$diam = 2 \cdot r$

$\Rightarrow \boxed{r = 25}$ mm

$A = 3,14 \cdot 25^2 =$

$$\boxed{Q = A \cdot v_1}$$

$Q = \frac{3,14}{60}$ m³/s, $A = 3,14 \cdot 625 \cdot 10^{-6}$

$$v_1 = \frac{Q}{A} = \frac{3,14}{60}\frac{m^3}{s} \cdot \frac{1}{3,14 \cdot 625 \cdot 10^{-6}\ m^2} = \frac{10^6}{60 \cdot 625}\frac{m}{s}$$

$$\Rightarrow v_1 = 27 \frac{m}{s}$$

2) Pentru evacuare

$P_1 = 1 atm = 10^5$ Pa $\Rightarrow R = 8,31 \cdot \frac{J}{mol \cdot K}$

$$p \cdot V = \nu R T$$

$$p_1 \cdot V_1 = \nu R T_1 \Rightarrow \nu = \frac{p_1 V_1}{R \cdot T_1} \Rightarrow \boxed{\nu = \frac{10^5 \cdot V_1}{R \cdot 300}}$$

$$\nu = \frac{p \cdot V}{RT}$$

$$p \cdot V = \nu R T$$

$$p \cdot V = \frac{m}{M} R T \quad | : V$$

$$p = \frac{\rho}{\mu} R T$$

$$p_1 = \frac{\rho_1}{\mu} R T_1 \Rightarrow R = \frac{p_1 \mu}{T_1 \rho_1}$$

$$p_2 = \frac{\rho_2}{\mu} R T_2 \Rightarrow R = \frac{p_2 \cdot \mu}{T_2 \cdot \rho_2}$$

$$\Rightarrow \frac{p_1 \cdot \cancel{\mu}}{T_1 \rho_1} = \frac{p_2 \cdot \cancel{\mu}}{T_2 \rho_2} \Rightarrow \frac{p_1}{T_1 \rho_1} = \frac{p_2}{T_2 \rho_2}$$

$$\frac{p_1}{T_1 \cdot \frac{\cancel{m}}{V_1}} = \frac{p_2}{T_2 \cdot \frac{\cancel{m}}{V_2}} \Rightarrow \frac{p_1 V_1}{T_1} = \frac{p_2 V_2}{T_2}$$ - volume

$$V_2 = \frac{8}{15} V_1$$ - volume

m - constantă
ν - constantă
$$\Rightarrow \boxed{\frac{p_1 V_1}{T_1} = \frac{p_2 V_2}{T_2}}$$

pe vrere - vlare - m ale

viteza

$$\rho_1 A_1 v_1 = \rho_2 A_2 v_2$$

$$\rho = \frac{p}{RT} \Rightarrow \begin{cases} \rho_1 = \frac{p_1}{RT_1} \\ \rho_2 = \frac{p_2}{RT_2} \end{cases}$$

$$v_2 = \frac{\rho_1 A_1 v_1}{\rho_2 A_2}$$

$A = \pi r_2^2$

$r_2 = \frac{d_2}{2} = \frac{20}{2} = 10\ mm = 0{,}01\ m$

$A_2 = 3{,}14 \cdot (0{,}01)^2 = 3{,}14 \cdot 0{,}0001$

$$\frac{P_1}{RT_1} \cdot A_1 v_1 = \frac{P_2}{RT_2} \cdot A_2 v_2$$

$$\Rightarrow v_2 = \frac{P_1}{RT_1} A_1 v_1 \cdot \frac{RT_2}{P_2 A_2}$$

$$= \frac{1}{R} \cdot \frac{3{,}14 \cdot 0{,}000625}{300} \cdot v_1 \cdot R \cdot 320 \cdot \frac{1}{2 \cdot 3{,}14 \cdot 0{,}0001}$$

$$= \frac{32}{2 \cdot 30} \cdot \frac{0{,}000625}{0{,}0001} \cdot v_1$$

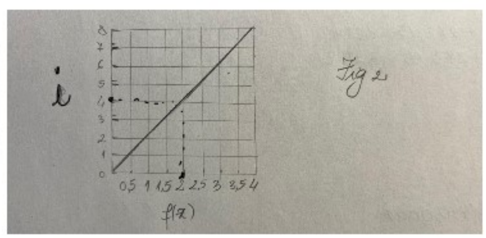
$$= 3{,}33 \cdot v_1$$

4. Considerăm un inductor pentru care relația $\lambda = \varphi(i)$ poate fi descrisă prin $\lambda = Li$, unde L este exprimat în H și i în A. Pentru $L = 10\ mH$ și semnalul de curent descris în Figura 2, energia acumulată în inductor în primele 2 secunde este

Liniar inductance

$$\lambda = L \cdot i$$

$$T = T^* = (1/2L) \cdot \lambda^2 = \frac{1}{2} \cdot L i^2$$



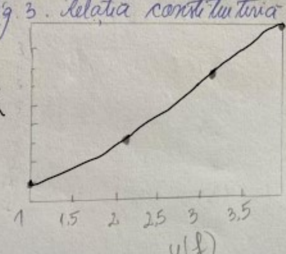
$L = 10mH = 0{,}01H$

$\lambda = 10mH \cdot i$

$$T = \frac{1}{2L} \cdot \lambda^2 = \frac{1}{2L} \cdot L^2 \cdot i^2 = \frac{L \cdot i^2}{2} = \frac{0{,}01 \cdot 4^2}{2} = 8 \cdot 10^{-2}$$

cheecha

3. Pt. un ~~re~~zistor s-au ridicat experimental punctele caracteristicii i-f(v) din Fig. 3. Relația constitutivă se poate exprima prin:

Fig3


A) Ec. neliniară
B. Ec. liniară
C. Fct. polinomială ✓
D. Ec. diferențiala ordinara

oopsielem

are curva

polinomială —› neliniară

6. Dacă semnalul de curent din fig. 2 este aplicat rezistorului, energia disipată în primele 2 secunde este:

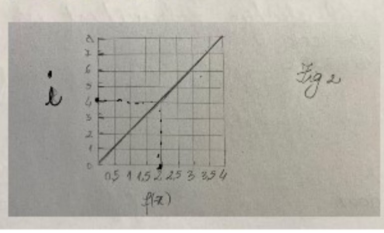


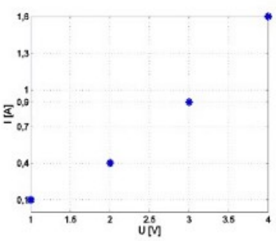
Fig 2

(amperi/sec)

(2) -> timp ... de 2 sec

$E = \int_0^{} U \cdot i =$

6. If the current signal shown in Figure is applied to the resistor, the energy dissipated in the first two seconds is:



$\boxed{U = \sqrt{10}\, I^{1/2}}$, $I = 2\,t$

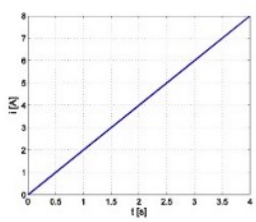
$$E = \int U \cdot I \; dt = \sqrt{10} \int_0^2 I^{3/2}\, dt = \sqrt{10} \int_0^2 (2\,t)^{3/2}\, dt$$

$$= \sqrt{10} \cdot 2^{3/2} \int_0^2 t^{3/2}\, dt$$

$$= \sqrt{10} \cdot 2^{\frac{3}{2}} \cdot \left. \frac{t^{\frac{3}{2}+1}}{\frac{3}{2}+1} \right|_0^2$$

$$= \frac{\sqrt{10}}{5} \cdot 2^{\frac{3}{2}} \cdot 2 \cdot 2^{\frac{5}{2}} = \frac{\sqrt{10}}{5} 2^5$$

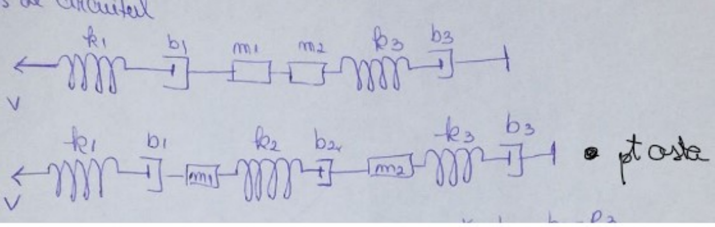
Care e tare.



7. Dacă în sistemul mecanic din Figura 4 se intercalează între masele m_1 și m_2 un resort k_2 și un amortizor b_2, atunci un model electric echivalent este descris de circuitul

Fig 4

Fig 4 modif.

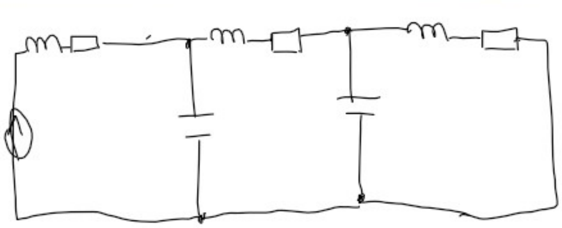


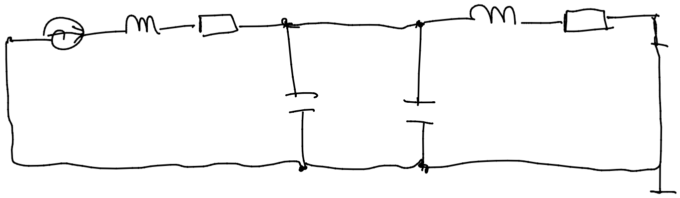
$v = u$

$k_1 = L_1$

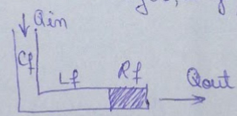
$b_1 = R_1$

$m_1 = C_1$

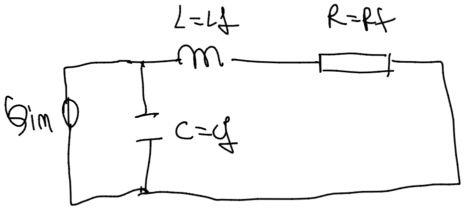




8. Pentru sistemul hidraulic de mai jos, alegeți modelul electric echivalent:



L R - serie
C - paralel



2019

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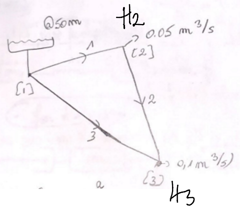
② For the hydraulic network in the figure above, the relation between Heat loss and flow can be modeled as: $Q_{ij} = \frac{(H_i - H_j)^a}{f_{ij}^a}$. The value of the resistance coefficients for pipes are:

$f_{12} = f_{13} = 200$; $f_{23} = 100$.

a) find the mathematical model that allows the computation of the flow rate in each pipe, as a system of equations, when $a = 0.5$.

b) Calculate the power disipated on each pipe for the linear case (when $a = 1$).



$$Q_{ij} = \frac{(H_i - H_j)^a}{f_{ij}^a}$$

$$f_{12} = f_{13} = 200$$
$$f_{23} = 100$$

a)
$$\begin{cases} Q_{12} = \dfrac{(H_1 - H_2)^{0,5}}{(200)^{0,5}} \\ Q_{13} = \dfrac{(H_1 - H_3)^a}{200^a} \\ Q_{23} = \dfrac{(H_2 - H_3)^a}{100^a} \end{cases}$$

flow rates

$$H_1 = 50$$
$$H_2 : Q_{12} - Q_{23} - r_2 = 0$$
$$H_3 : Q_{13} + Q_{23} - r_3 = 0$$

$$H_2 : \operatorname{sgn}(H_1 - H_2)\left(\frac{(|H_1 - H_2|)^{0,5}}{(200)^{0,5}}\right) - \operatorname{sgn}(H_2 - H_3)\left(\frac{(|H_2 - H_3|)^{0,5}}{100^{0,5}}\right) - r_2 = 0$$

$$H_3 : \operatorname{sgn}(H_1 - H_3)\left(\frac{|H_1 - H_3|}{200}\right)^{0,5} + \operatorname{sgn}(H_2 - H_3)\left(\frac{|H_2 - H_3|}{100}\right)^{0,5} - r_3 = 0$$

b) $I = \frac{U}{R}$ $\quad P = U \cdot I$ $\quad P = \frac{U^2}{R}$

facem analogia hidro - el

$\Rightarrow U = H$

$R = f$

$a = 1 \Rightarrow$

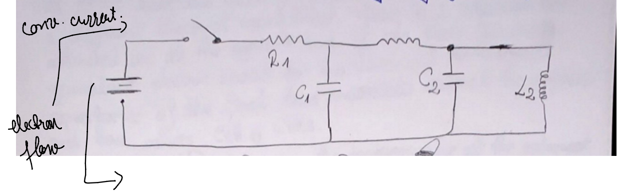
$$P_{12} = \frac{(H_1 - H_2)^2}{(f_{12})^1}$$

$$H = 0,05 \cdot R$$

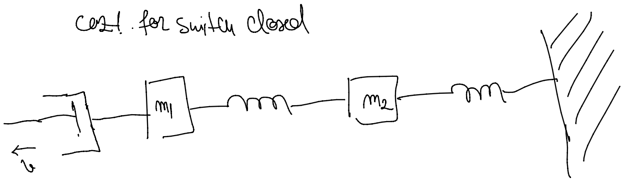
$$P_{13} = \frac{(H_1 - H_3)^2}{(f_{13})^1}$$

$$P_{23} = \frac{(H_2 - H_3)^2}{(f_{23})^1}$$

③ For the electrical circuit in the figure below, find and draw the mechanical analogie ~~x~~ for the system.

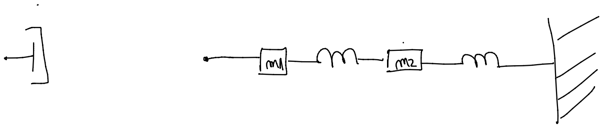


caz1. for switch closed



caz2 for switch open

?

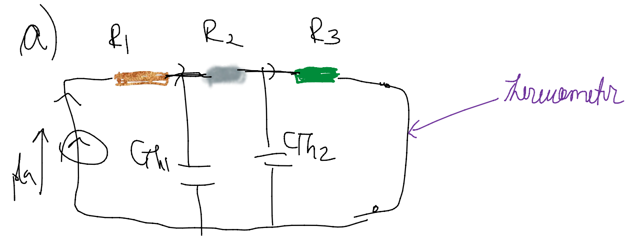


④ Consider a heat source attached to a block composed of three materials with different characteristics (each with a different thermal resistance). There is a thermometer attached on at the opposite end of the block. Draw the thermal equivalent electric circuit for two cases: ⓐ the thermal capacitance of the first two materials cannot be neglected and have values C_{th1}, C_{th2}.

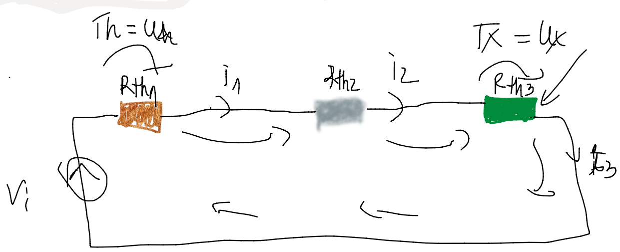
For case ⓑ, determine the temperature of the outermost wall of the block if the wall connected to the next source has the temperature T_h.

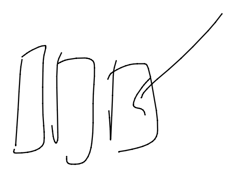
$$U = I \cdot R$$

a)



b)





	Electrical Domain			Thermal Domain		
Through Variable (FLOW)	Current	I	Amperes or Coulombs/s	Power or heat flux	P_D	Watts or Joules/s
Across Variable (EFFORT)	Voltage	V	Volts	Temperature	T	°C or K
Resistance	Electrical resistance	R	Ohms	Thermal resistance	$R_{\Theta AB}$	°C/W or K/W
Capacitance	Electrical capacitance	C	Farads or Coulombs/V	Thermal Capacitance	C_{Θ}	Joules/°C
„Ohm's Law"	$\Delta V_{AB}=V_A-V_B=I \cdot R_{AB}$			$\Delta T_{AB}=T_A-T_B=P_D \cdot R_{\Theta AB}$ (derived from Fourier's Law)		

temperatura - cădere de tensiune

$$\boxed{U_{Rth_3} = V_i - U_{Rth_1} - U_{Rth_2}}$$

5) A sensor provides N readings for the output variables (y), corresponding to N temperature values (x)

a) Assumming a linear transfer curve ($y = ax + b$) and, by employing the method of least squares, find an analytical formula for the values of the parameters a and b that minimize the error $J(a,b)$, of the assumption, where

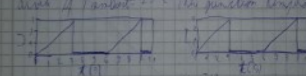
$$J(a,b) = \sum_{n=1}^{N} \left(y_n - (a x_n + b)\right)^2$$

b) Let $N = 5$ and the input / output values $x = \{120, 150, 180, 200, 250\}$, $y = \{130, 170, 200, 250, 300\}$. What is the error associated to the parameters values: $a = 10$ and $b = 1$?

?

a

Ne uitam pe lab



9. A semiconductor device mounted a heatsink is characterised by the following ..... of the ..... heatsink, heatsink-ambient thermal resistances: $R_{\theta JC} = 12°C/W$, $R_{\theta CR} = 6°C/W$, $R_{\theta RA} = 3°C/W$

a) the current (i) and the voltage (u) profiles applied to the device

b) If $T_{ambient} = 27°C$, the a... is:

A. 135°C, B. 90.5°C, C. 58.5°C, D. 21°C

$$T_{ambient} = 27°C \Rightarrow \boxed{U = 27V}$$

$$R_T = R_{SC} + R_{CR} + R_{RA} = 21\ \Omega$$

$$T_A = 27°C$$

$$T_{Total} = T_A + T_{med}$$

$$\boxed{T_{Total} = T_A + P_{med} \cdot R_T}$$

$$\boxed{P_{medie} = \frac{1}{T} \cdot \int_0^T f(t)\,dt}$$

perioada

Puterea el.

$T = 6$

$$f(t) = V \cdot I = t \cdot t = t^2 \quad (\text{stiu că între } 0 \text{ și } 3 \quad u = i = t)$$

$\Rightarrow$

$$\Rightarrow P_{med} = \frac{1}{6} \int_0^6 t^2 + 0\,dt = \frac{1}{6} \cdot \frac{t^3}{3}\Big|_0^3 = \frac{1}{6} \cdot \frac{27}{3}$$

$$\Rightarrow P_{mod} = \frac{1}{6} \int_0^6 t^2 \, dt = \frac{1}{6} \cdot \frac{t^3}{3} \Big|_0^3 = \frac{1}{6} \cdot \frac{27}{3}$$

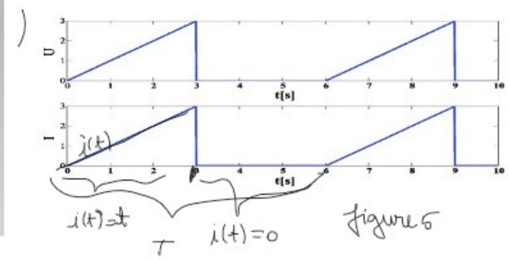
$$= 1{,}5$$

$$\Rightarrow T_{total} = T_A + 1{,}5 \cdot 21$$

$$T_{total} = 27 + 1{,}5 \cdot 21 = 58{,}5\,^\circ C$$ ✓

10. If the current profile of Figure 5 is applied to a voice coil acuator, characterized by the equation $F(t) = K_f \cdot i(t)$ having the mass $m = 3$ and $K_f = 2$, with the initial conditions $i(0) = 0$, $x(0) = 0$, $v(0) = 0$, then the values the velocity at time $t = 3$ is:

A. 3/2, B. 9, C. 6, $\boxed{\text{D. 3}}$



$$\boxed{F(t) = K_f \cdot i(t)}$$

$K_f = 2$, $m = 3$, $i(0) = 0$, $x(0) = 0$, $v(0) = 0$

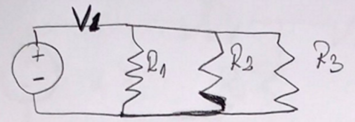
$t = 3$

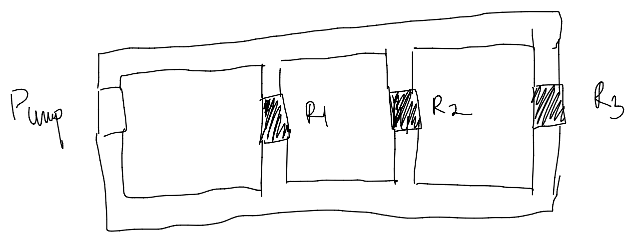
$$i(t) = \begin{cases} t, & t \in [0, \frac{T}{2}) \\ 0, & t \in [\frac{T}{2}, T] \end{cases}$$

$$\boxed{v = \frac{1}{m} \int_0^T K_f \cdot i(t) \, dt}$$

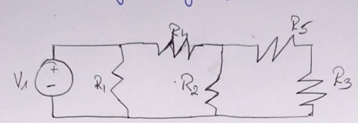
$$v = \frac{1}{3} \int_0^3 2 \cdot t \, dt = \frac{2}{3} \frac{t^2}{2} \Big|_0^3 = \frac{2}{3} \cdot \frac{9}{2} = 3$$

11. Draw the equivalent hydraulic system for the circuit shown in the following figure.





12. Draw the equivalent hydraulic system for the circuit shown in the following figure.



ANS: